Analysis of macular thickness by spectral domain OCT in normal healthy population of Gujrat, India

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Abstract

Introduction: Study was conducted to analyse the average macular thickness globally from different age group from the healthy Indian population. Study will help to quantify any difference in thickness between gender and right and left eye too. Data can be compared with different ethnic groups.

Materials and Methods: In total 147 patients have been enrolled in study attending daily ophthalmology out patient department. Age distribution of patients are 11 to 75 years. After patient fits inclusion criteria, single handed macular thickness measurement by spectral Domain OCT was carried out after consent. Measurement area is automatically identified by placing rim of 1mm, 3mm and 6mm diameter evenly around the centre of macula. Here we have encountered only central subfoveal values. Then macular thickness is calculated itself by algorithm. Protocol also displays binocular symmetry. To make sure for the accuracy of the results only the signal strength of 6 or higher and binocular symmetry more then 85% will be accepted in our study. Each patient was scanned single time with accuracy. Change in macular thickness was calculated by using paired sample t test, independent sample t test and T- test assuming equal variences.

Result: Mean central subfoveal thickness for our population is 238.7278±14.2460 µ. However for different age group A,B,C and D the values for central subfoveal thickness are 241.9038±14.6972µ, 241.6428±8.2017µ, 235.5681±14.3381µ and 236.8428±18.1032µ respectively. There is weak negative corelation between left eye macular thickness and age which is statistically significant (r= -0.22)(p=0.005) (95% CI for r= -0.37 to 0.06). There is no correlation between right eye macular thickness and age (r= -0.07)(p=0.35) (95% CI for r= -0.23 to 0.08). The mean±SD values for Right and Left eye are 237.5986±13.7804 and 239.8571±14.6568µ respectively. In paired t test for right and left eye macular thickness difference is statistically significant (p=0.0043)(95% CI -3.7967 to- 0.7203). Mean values for different age group A,B,C and D for right eye are 239.1923±13.7579µ, 240.2380±7.9994µ, 233.4318±14.5496µ and 238.4857±17.2496µ respectively. While for the left eye 244.6153±15.3650µ, 243.0476±8.2549µ, 237.7045±13.9610µ and 235.2000±19.0259µ respectively. Normative values we found for male and female are 238.5735±13.4868µ and 238.9556±14.9075µ respectively. Difference in right and left macular thickness in male and female is not statistically significant as (p=0.5867,p=0.9221)(95%CI-5.6616 to 3.2148, -4.5699 to 5.0468). Mean±SD for different age group A, B, C and D for male are 242.8076±12.7059µ, 240.8157±8.0868µ, 236.6052±14.1240µ and 234.5882µ respectively. While for left eye central subfoveal thickness for different age group A,B,C and D are 241.00±16.6589µ, 242.3260±8.3214µ, 234.7800± 14.5914µ and 238.9722±19.1989µ respectively.

Conclusion: Study has provided normative data of central subfoveal thickness for normal west Indian population. Normative values derived from this study can be used for different macular diseases in which macular thickness either increases or decreases. However studies from different ethnic group shows different mean values for macular thickness. This should be considered while diagnosing any macular pathology involving thickness. In our study difference between gender is not statistically significant while difference between right and left eye shows significant difference.

Keywords: Foveal fixation, Macula, Maculopathy, Optical coherence tomography, Subfoveal thickness.

Introduction

Optical coherence tomography (OCT) generates cross-sectional images of the retina by measuring the echo time delay and magnitude of backscattered light.[17,18] Here Analysis of macular thickness is done with spectral domain optical coherence tomography. Traditional methods for evaluating macular edema, such as slitlamp biomicroscopy, stereoscopic photography, and fluorescein angiography, are relatively insensitive to small changes in retinal thickness.[1,9] OCT is an objective method of quantitatively determining the macular characteristics.[5] Ability to produce high resolution and cross-sectional images accurately and precisely,[20,21] And it is purely noninvasive; all of which enable diagnosis, management and monitoring of patients with retinal diseases.[19] It also gives layer by layer details of retina. It is a high resolution, noncontact, noninvasive, quantitative biological tissue imaging technology.[22] No harm of ionizing radiation and gives live sub surface images at near microscopic resolution. It is based on principle of 2 or 3 dimensional cross sectional imaging of retina by measuring echo delay and intensity of back reflected infrared light from internal tissue structure. Highly reflective structures are shown in bright colors (white and red) and those with low reflectivity are shown as dark colored (black and blue). Intermediate reflectivity is shown as green. Spectral domain OCT has advantage of high speed and high axial resolution of 7-8 micrometer. As it generates clear images more

then ever, it has become an unparalleled guide for objective and accurate diagnosis and follow up in clinical ophthalmology. Prior to labelling the macula as abnormal, it is important to determine the range of normal macular thickness.[16] Macular oedema is common cause of visual disturbance in diseases like diabetic retinopathy, posterior uveitis, following retinal vein occlusion or following intraocular surgeries like cataract. Optical coherence tomography (OCT) is a non-invasive imaging technology, widely used in clinical practice to evaluate retinal thickness and the presence of structural changes in retinal diseases.[15] The introduction of optical coherence tomography (OCT) has enabled clinicians to reliably detect and measure small changes in macular thickness and to quantitatively evaluate the efficacy of different therapeutic modalities.[2,9,14]

Inclusion Criteria: We have randomly enrolled 147 patients attending our daily OPD. Patients of age from 11 to 75 years of both sex and who had agreed to participate in study are enrolled in study.

Exclusion Criteria: Patients having high refractive error (more then 5.0 dioptor of spherical and more then 3.5 dioptor of astigmatism), best corrected visual acuity <20/25, history of any intraocular surgery, dense cataract, amblyopia, any retinal or optic nerve pathology, abnormal foveal fixation, media opacity, trauma, IOP >21 mmHg, glaucoma suspect, diabetic maculopathy, hypertensive maculopathy, age related macular degeneration or patients having any other macular pathology are not enrolled in study.

Materials and Methods

In total 147 patients will be enrolled in study attending daily ophthalmology out patient department.

At first all the participants underwent BCVA, pin hole visual acuity, colour vision and thorough eye examination through slit lamp. Intraocular pressure by applanation tonometer was measured. Then patient went for dilatation with 0.5% tropicamide drops and examined for any macular pathology with slit lamp biomicroscopy. If patient fits inclusion criteria then single handed macular thickness measurement by cirrus HD OCT was carried out after consent. The OCT machine has inbuilt 512 x 128 axial protocol which was used for macular evaluation. Patient is positioned with proper chinrest and head rest. Chinrest is adjusted to correct eye position. Data to compensate for refractive error and other personal data like name, sex, birthdate, patient ID No. entered. Patient is asked to look at internal fixation point inside the lens. Then scanning was done with signal strength 6.0 or more. Measurement area is automatically identified by placing a 1 mm, 3 mm and 6 mm diameter rim evenly around the centre of macula. Then macular thickness is calculated itself by algorithm. Macula was divided by two lines which form 45 degree to vertical line on both side from the centre of fovea and divided into superior, inferior, nasal and temporal quadrants. We have considered central subfoveal thickness only. Protocol also displays binocular symmetry. To make sure for the accuracy of the results only the signal strength of 6 or higher and binocular symmetry more then 85% will be accepted in our study. Each patient was scanned single time with accuracy. Study was conducted after taking permission from Institutional Human Ethics Committee of the Institute.

Result

Thickness was measured as mean ± standard deviation. All the data was run the independent sample t test and T test assuming equal variences. Independent sample t test involves arithmetic mean, 95% CI for the mean, standard deviation and F test for equal varience. While T test assuming equal variences involves difference, standard error, 95% CI of difference, test statistic t, degree of freedom and two tailed probability.

Mean central subfoveal thickness for our population is 238.7278±14.2460µ. However age wise distribution has been shown in table 1. In our study we have found there is significant negative correlation for macular thickness and age for left eye (r= -0.22)(p=0.005) (95% CI for r= -0.37 to 0.06). That means macular thickness of left eye shows decrease in thickness with increasing age. While we found no any correlation between macular thickness of right eye and age. Which signifies that macular thickness of right eye does not show any significant changes with increasing age?

Mean±Standard deviation for right eye and left eye central subfoveal thickness are 237.5986±13.7804µ and 239.8571±14.6568µ respectively. Age wise distribution for macular thickness has been given in table 2. In our study in paired t test for right and left eye central subfoveal thickness shows statistically significant difference (p=0.0043) (95% CI -3.7967 to- 0.7203).

Average value of subfoveal macular thickness for male and female are 238.5735±13.4868µ and 238.9556±14.9075µ respectively. Gender distribution for central subfoveal macular thickness is given in table 3. Difference in right and left macular thikness in male and female is not statistically significant as (p=0.5867,p=0.9221) (95%CI-5.6616 to 3.2148, -4.5699 to 5.0468). That means there is no any significant difference in thickness value between gender.

Table 1: Age distribution for subfoveal thickness in µm

Age (yrs)	Macular Thickness
11-20 (group A)	241.9038±14.6972
21-40 (group B)	241.6428±8.2017
41-60 (group C)	235.5681±14.3381
61-75 (group D)	236.8428±18.1032

Table 2: Eye distribution of subfoveal thickness in µm

Age (yrs)	RE	LE
11-20 (Group A)	239.1923±13.7579	244.6153±15.3650
21-40 (Group B)	240.2380±7.9994	243.0476±8.2549
41-60 (Group C)	233.4318±14.5496	237.7045±13.9610
61-75 (Group D)	238.4857±17.2496	235.2000±19.0259

Table 3: Gender Distribution of subfoveal thickness in mm

Ag (yrs)	Male	Female
11-20 (Group A)	242.8076±12.7059	241.0000±16.6589
21-40 (Group B)	240.8157±8.0868	242.3260±8.3214
41-60 (Group C)	236.6052±14.1240	234.7800±14.5914
61-75 (Group D)	234.5882±16.8561	238.9722±19.1989

Table 4: Ethnic variation for Central subfoveal Thickness

Ethnicity	Study	Central subfoveal thickness in µm
Thai population	Thai study[23]	183.2±1.3
Norway population	Tromsø study (2007-2008)[15]	265.9±21.4
Iranian Population	Iranian study et al[9]	251.39±20.57
Chinese Population	Handan eye study[13]	150.3±18.1
Indian Population	Hem KT et al[27]	149.16±21.15
Egyptian Population	Mohammad AM et al[17]	262.70±19.64
Norwegian Population	Alexander Wexler et al[28]	178.0±22.0
Korean Population	Won Jae Yon et al[26]	268.6±19.1
Spenish Population	Sole Gonzalae et al[29]	261.31±17.67
West Indian Population	Our study	238.7278±14.2460

Discussion

In our study we can see that right eye does not show any correlation with age while left eye shows significant negative correlation with increasing age. As compared to our study, study conducted in Punjab shows that there was no correlation between macular thickness and age (r=0.109, p=0.275).[7] A study carried out in Thai population shows significant association between age and macular thickness in all areas except in the center.[23] The study of Ooto et al.[15,25] found increased retinal thickness of the fovea with significantly increased thickness of both photoreceptor outer segments and outer plexiform and nuclear layer by higher age, while the study of Demirkaya et al.[15,24] found reduction in the retinal outer segment layer by higher age and no change in the other layers of the fovea. In Duan XR et al study conducted in in Chienese population shows age was positively correlated with foveal (beta coefficient = 3.582) and central macular (beta coefficient = 2.422) thicknesses.[13] In Iranian study using the linear regression analysis, they concluded that there was a significant correlation between age and the average thickness (p<0.001).[9] With each year of increase in age, there was a 0.266 µm decrease in the average thickness.[9]

In our study we have seen that there is no any correlation between male and female for subfoveal thickness (p=0.5867,p=0.9221) (95%CI-5.6616 to 3.2148, -4.5699 to 5.0468). Duan et al.[13] and Ooto et al.[25] Study shows that there is good evidence that women have thinner retina than men. Tromrso eye Study shows Women had thinner retina in the fovea and pericentral ring than men; while in the peripheral ring, women had thinner retina in the temporal sector only.[15] Tiwari HK et al. shows no significant difference was seen in average foveal thickness and minimum foveal thickness in males as compared to females.[11] While study of Zia SP et al. shows females had a significantly thinner fovea (176.71 ± 23.32 µm v/s. 193.24 ± 20.95 µm) and inner macula ($p < 0.001$) as compared to males.[16] There was no correlation between macular thickness and either age (r=0.109, p=0.275) or gender (Eta=0.128).[24] In a study conducted in Thailand also shows no significant difference between sexes in either eye laterality ($P = 0.524$).[23] However recent studies using SD-OCT also reported no significant difference in retinal thickness between men and women.[6,8,9] Result of which are consistent with our results.

In our study in paired t test for right and left eye macular thickness difference is statistically significant (p=0.0043) (95% CI -3.7967 to- 0.7203). This difference between right and left eye should be encountered for treating any diseases involving macula. However we could not find any study showing or comparing central subfoveal thickness between right and left eye.

Table 4 shows variation in central subfoveal thickness in different ethnic population.

From above comparison it is concluded that different ethnic population shows wide variation in foveal thickness. So the average value for different ethnic population is very much important for diagnosis and treatment of patient from different geographic area.

Conclusion

Study will help to get some average normal value for macular thickness of Indian population. Which is expected to provide the standard database for recognizing macular thickness changes while diagnosing, treating and following progression of macular diseases in India. As the percentage of people with macular diseases is increasing in Indian population with highest morbidity, evaluation of macular thickness in normal Indian population will be helpful.

Conflicts of Financial Interest: None

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